PREFACE

In 1993, radioactive waste-management practices of the former Soviet Union (FSU) came under increasing international scrutiny after Russian scientists disclosed dumped-nuclear-waste sites in the Kara and Barents seas that contravened the London Convention ban on radioactive waste disposal at sea. The U.S. response was to fund the Office of Naval Research Arctic Nuclear Waste Assessment Program (ANWAP) to (1) quantify the types, amounts, and rates of release of radionuclides from marine disposal sites and Russian riverine sources leading to Arctic waters; (2) evaluate the transport pathways and ultimate fate of the radionuclide contaminants; and (3) identify any long-term monitoring strategies as needed. ANWAP began funding basic physical, geochemical, and biological oceanographic research in the Arctic in 1993.

By early 1995 the second year of ANWAP research was well under way and planning for the final ANWAP funding cycle emphasized the need to better coordinate and integrate the activities and results of the 85 research projects into a risk-assessment framework. The goal: to use data sets in a rigorous evaluation process to make dose estimates for potential human and ecological impacts, particularly in Alaska, from the nuclear wastes the FSU had dumped in the Arctic. A Risk Assessment Integration Group (RAIG) was formed to conduct the assessment. The RAIG recognized at the outset of this risk-assessment phase that the risk analysis would have to depend on available ANWAP data and other published data sets, and that ongoing research would continue to generate new data even after the data cutoff point for timely preparation of the risk assessment. The RAIG has established an evaluation framework that, through an ongoing iterative process, can be enhanced as new information becomes available.

The risk assessment follows a traditional, internationally accepted radiological risk-assessment process. It uses models to make predictions, but also incorporates actual field measurements and laboratory data obtained from ANWAP scientists and the broader national and international scientific community. The risk-assessment team involved key scientists from Alaska (Douglas Dasher, Department of Environmental Conservation, and Todd O'Hara, North Slope Borough Department of Wildlife Management); Lawrence Livermore National Laboratory (David Layton, Mark Mount, Florence Harrison, and John Knezovich); Sandia National Laboratories (Rip Anderson, Mel Marietta, Leo Gomez, and Palmer Vaughn); Battelle Pacific Northwest Laboratories (William Templeton and Bruce Napier); and the Office of Naval Research (Marilyn Varela). This integrating team (the RAIG) identified discrete areas of focus and authorship for various components of the risk assessment; in the preparation of this report, the team relied upon the input of key ANWAP Principal Investigators, some of whose information was timely enough for use, and some not. Each section of the report identifies the authors. Although inputs from Russian contributors were instrumental in developing the description of the current disposition of FSU wastes, this report represents strictly a U.S. interpretation of the consequences implied by their information.

The sources of radioactive release evaluated in this report are those currently in or entering the Arctic Ocean. The coupled modeling and risk-assessment methodology developed for these marine sources, however, are applicable to other potential sources. Such sources could include nuclear submarines and decommissioning products, or stored spent nuclear fuel (SNF) at military bases

in Murmansk or Vladivostok. While these sources potentially could be very large, this report does not address them because they are outside ANWAP's original mandate, and they are under Russian institutional control. It also does not directly address other Alaskan sources, such as residual contamination on Amchitka Island or residues from Project Chariot. These instances of localized Alaskan contamination are addressed only as they impact the current measurable background in Arctic waters.

This report is *not* the ANWAP Final Report of all research efforts. Much more ANWAP research work still is being finalized; thus, it has not yet become available for use in risk assessments. The authors of this risk assessment, however, have followed the development of the other ANWAP projects and anticipate that no yet-to-be-published work will greatly alter the conclusions of this report. Scientists involved in ANWAP have recommended many future research efforts; the 1996 Annual Synthesis Meeting comprehensively addressed future-work priorities, which are presented in the summary report of that meeting (ONR, 1997). Individual investigator reports in the annual program summary books for 1993 to 1994 (ONR 322–95–5) and 1995 (ONR 3322–96–16), the 1996 summary (in preparation), and the various ANWAP annual reports to Congress contain additional recommendations.

This risk-assessment report represents a stringent technical undertaking reflecting interdisciplinary collaboration and use of the most recent available data. The principal audience is the technical community, although the Executive Summary and the summary paragraphs within the various sections of the report should assist those unfamiliar with the radiological risk-assessment process and health physics. Another document, intended for a public audience, will complement this technical report.

Simultaneously with this ANWAP risk-assessment effort, the International Atomic Energy Agency (IAEA) International Arctic Seas Assessment Program (IASAP) has been conducting a major program focusing solely on the Kara Sea's FSU-dumped nuclear materials and localized Kara Sea impacts. The more extensive ANWAP project, which has involved some riverine land-based sources, as well as an assessment of cross-Arctic-basin transport processes for a focus on potential Alaskan consequences, complements the IAEA initiative.